NHBFEE ISSN: 1040-7790

NUMERICAL HEAT TRANSFER

An International Journal of Computation and Methodology

PART B: FUNDAMENTALS

Volume 31
1997

Taylor & Francis
Publishers since 1798

NUMERICAL HEAT TRANSFER

An International Journal of Computation and Methodology

PART B: FUNDAMENTALS

Editor-in-Chief
W. J. MINKOWYCZ
The University of Illinois at Chicago
Department of Mechanical Engineering (MC 251)
842 West Taylor Street, Room 2049
Chicago, Illinois 60607-7022
Tel: (312) 996-3467/5317
Fax: (312) 413-0447
e-mail: wjm@uic.edu

Editorial Associate: **R. M. Szandra**

EDITORIAL ADVISORY BOARD

E. M. Sparrow, *Chairman*
Minneapolis, Minnesota

A. J. Baker, *Knoxville, Tennessee*
A. Bejan, *Durham, North Carolina*
P. Cheng, *Kowloon, Hong Kong*
T. J. Chung, *Huntsville, Alabama*
S. W. Churchill, *Philadelphia, Pennsylvania*
G. Comini, *Udine, Italy*
G. de Vahl Davis, *Kensington, Australia*
E. R. G. Eckert, *Minneapolis, Minnesota*
B. A. Finlayson, *Seattle, Washington*
B. Gebhart, *Philadelphia, Pennsylvania*
Y. Jaluria, *Piscataway, New Jersey*
B. E. Launder, *Manchester, UK*
B. P. Leonard, *Akron, Ohio*
H. Orse, *Fukuoka, Japan*
S. V. Patankar, *Minneapolis, Minnesota*
D. W. Pepper, *Las Vegas, Nevada*
M. Peric, *Hamburg, Germany*
R. H. Pletcher, *Ames, Iowa*
G. D. Raithby, *Waterloo, Ontario*
S. Ramadhyani, *West Lafayette, Indiana*
P. J. Roache, *Alburquerque, New Mexico*
G. E. Schneider, *Waterloo, Ontario*
T. -M. Shih, *College Park, Maryland*
W. Shyy, *Gainesville, Florida*
D. B. Spalding, *London, UK*
K. K. Tamma, *Minneapolis, Minnesota*
J. F. Thompson, *Mississippi State, Mississippi*
C. L. Tien, *Berkeley, California*
K. E. Torrance, *Ithaca, New York*
S. P. Vanka, *Urbana, Illinois*
R. Viskanta, *West Lafayette, Indiana*

Aims and Scope: *Numerical Heat Transfer, Part B: Fundamentals* is an international journal devoted to publishing papers on all aspects of the methodology for the numerical solution of problems of heat transfer, mass transfer, and fluid flow. Also within the scope of the journal is the modeling of complex physical phenomena prerequisite to the attainment of numerical solutions. Papers presenting numerical or experimental results that support the methodology development are also appropriate to the journal. On the other hand, papers whose dominant thrust is the attainment and presentation of numerical results should be submitted to a companion journal, *Numerical Heat Transfer, Part A: Applications.*

This journal will be published in two volumes, each containing four issues, for a total of eight issues scheduled for publication in 1997.

Abstracted and / or Indexed in: Chemical Abstracts, Current Contents: Engineering, Computing, and Technology, Engineering Information Inc., Information Service in Mechanical Engineering (ISMEC), Materials Science Citation Index™ Nova Information Services Co., Research Alert, Science Citation Index, and SciSearch.

Editorial Office: W. J. Minkowycz, The University of Illinois at Chicago, Department of Mechanical Engineering (MC 251), 842 West Taylor Street, Room 2049, Chicago, Illinois 60607-7022.

Publishing and Production Offices: Taylor & Francis, 1101 Vermont Avenue, NW, Suite 200, Washington, DC 20005-3521, phone (202) 289-2174, fax (202) 289-3665, Mark Eggerts, Production Editor. **Advertising Office:** 1101 Frost Road, Suite 101, Bristol, PA 19007, phone (215) 785-5800, fax (215) 785-5515, Emily Kalata, Advertising Coordinator. **Subscriptions Office:** 1101 Frost Road, Suite 101, Bristol, PA 19007, phone (215) 785-5800; fax (215) 785-5515; or Taylor & Francis Ltd., Rankine Road, Basingstoke, Hampshire RG24 8PR, UK, phone +44-1256-840366, fax +44-1256-479438.

Numerical Heat Transfer, Part B: Fundamentals (ISSN 1040-7790) is published monthly (except in February, May, August, and November) in 8 issues per year by Taylor & Francis Ltd., 1 Gunpowder Square, London EC4A 3DE, UK. Annual 1997 institutional subscription UK £297, US $490. Personal subscription rate UK £168, US $278, available to home address only and must be paid for by personal check or credit card.

Periodicals postage paid at Jamaica, New York 11431. **U.S. Postmaster:** Send address changes to Numerical Heat Transfer, Part B: Fundamentals, Publications Expediting, Inc., 200 Meacham Avenue, Elmont, NY 11003. Air freight and mailing in the USA by Publications Expediting, Inc., 200 Meacham Avenue, Elmont, NY 11003.

Dollar rates apply to subscribers in all countries except the UK and the Republic of Ireland, where the sterling price applies. All subscriptions are payable in advance and all rates include postage. Subscriptions are entered on an annual basis, i.e., January to December. Payment may be made by sterling check, dollar check, international money order, National Giro, or credit card (AMEX, VISA, Mastercard/Access).

Orders originating in the following territories should be sent directly to: **India**—Universal Subscription Agency Pvt. Ltd., 101-102 Community Centre, Malviya Nagar Extn., Post Bag No. 8, Saket, New Delhi. **Japan**—Kinokuniya Company, Ltd., Journal Department, P.O. Box 55, Chitose, Tokyo 156, Japan. **USA, Canada, and Mexico**—Taylor & Francis, 1900 Frost Road, Suite 101, Bristol, PA 19007, USA. **UK and all other territories**—Taylor & Francis Ltd., Rankine Road, Basingstoke, Hampshire RG24 8PR, England.

Copyright © 1997 Taylor & Francis. All rights reserved. Authors are responsible for obtaining permission to reproduce copyrighted material from other sources and are required to sign an agreement for transfer of copyright to the publisher. Printed in the United States of America. Authorization to photocopy items for internal or personal use, of the internal or personal use of specific clients, is granted by Taylor & Francis for libraries and other users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that the base fee of $12.00 per copy, plus .00 per page is paid directly to CCC, 222 Rosewood Drive, Danvers, MA 01923, USA.

The publisher assumes no responsibility for any statements of fact or opinion expressed in the published papers. The appearance of advertising in this journal does not constitute an endorsement or approval by the publisher, the editor, or the editorial board of the quality or value of the product advertised or of the claims made for it by its manufacturer. **Numerical Heat Transfer, Part B: Fundamentals** is owned by Taylor & Francis.

♾ The paper in this publication meets the requirements of the ANSI Standard Z39.48-1984 (Permanence of Paper), effective with Volume 21, Number 1, 1992.

NUMERICAL HEAT TRANSFER

An International Journal of Computation and Methodology

PART B: FUNDAMENTALS

Vol. 31 No. 1
1997

CONTENTS

1 Numerical Method for the Computation of Flow in Irregular Domains That Exhibit Geometric Periodicity Using Nonstaggered Grids **K. M. Kelkar, D. Choudhury, and W. J. Minkowycz**

23 Efficiency and Accuracy Aspects of a Full-Multigrid SIMPLE Algorithm for Three-Dimensional Flows **Željko Lilek, Samir Muzaferija, and Milovan Perić**

43 Differential Total Absorptivity Solution to the Radiative Transfer Equation for Mixtures of Combustion Gases and Soot **N. W. Bressloff, J. B. Moss, and P. A. Rubini**

61 Fast, Narrow-Band Computer Model for Radiation Calculations **Zhenghua Yan and Göran Holmstedt**

73 Efficient Multilevel Finite-Element Approach to Three-Dimensional Phase-Change Problems **Rong-Tsong Lee and Wu-Yao Chiou**

91 New Bounded Skew Central Difference Scheme, Part I: Formulation and Testing **F. Moukalled and M. Darwish**

111 New Bounded Skew Central Difference Scheme, Part II: Application to Natural Convection in an Eccentric Annulus **F. Moukalled and M. Darwish**

NUMERICAL HEAT TRANSFER

An International Journal of Computation and Methodology

PART B: FUNDAMENTALS

Vol. 31 No. 2
1997

CONTENTS

135 Nonlinear, Subgrid Embedded Finite-Element Basis for Accurate Monotone, Steady CFD Solutions **Subrata Roy and A. J. Baker**

177 Entropy-Based Correction of Finite-Difference Predictions **Gregory F. Nellis and Joseph L. Smith, Jr.**

195 A Pressure-Based Method for Unstructured Meshes **S. R. Mathur and J. Y. Murthy**

217 Open Boundary Conditions for the Streamfunction–Vorticity Formulation of Unsteady Laminar Convection **G. Comini, M. Manzan, and G. Cortella**

235 Simulation of Annular Swirling Turbulent Flows with a New Algebraic Reynolds Stress Model **Jian Zhang, Huiping Lu, Lixing Zhou, and Sen Nieh**

251 An Inverse Source Problem in Radiative Transfer for Spherical Media **H. Y. Li**

NUMERICAL HEAT TRANSFER

An International Journal of Computation and Methodology

PART B: FUNDAMENTALS

Vol. 31 No. 3
1997

CONTENTS

261 A Direct (Pseudo-Spectral) Solver of the 2D/3D Stokes Problem: Transition to Unsteadiness of Natural-Convection Flow in a Differentially Heated Cubical Cavity **G. Labrosse, E. Tric, H. Khallouf, and M. Betrouni**

277 Spatial-Multiblock Procedure for Radiation Heat Transfer **John C. Chai and Jeffrey P. Moder**

295 High-Order Scheme Implementation Using Newton-Krylov Solution Methods **Richard W. Johnson, Paul R. McHugh, and Dana A. Knoll**

313 Modification of the Discrete-Ordinates Method in an Axisymmetric Cylindrical Geometry **Seung Wook Baek and Man Young Kim**

327 Enhancement of Flare Method for Predicting Buoyancy-Induced Flow Reversal in Vertical Ducts Via Parabolic Model **Chin-Hsiang Cheng, Shuen-Yi Huang, and Win Aung**

347 Performance Evaluation of Iterative Tomographic Algorithms Applied to Reconstruction of a Three-Dimensional Temperature Field **P. M. V. Subbarao, P. Munshi, and K. Muralidhar**

373 Spatially Fourth-Order-Accurate Scheme for Unsteady-Convection Problems **A. A. Mohamad**

NUMERICAL HEAT TRANSFER

An International Journal of Computation and Methodology

PART B: FUNDAMENTALS

Vol. 31 No. 4
1997

CONTENTS

387 Numerical Method for the Prediction of Free Surface Flows in Domains with Moving Boundaries **Kanchan M. Kelkar and Suhas V. Patankar**

401 Spatial Domain-Based Parallelism in Large-Scale, Participating-Media, Radiative Transport Applications **Shawn P. Burns and Mark A. Christon**

423 Prediction of Radiative Transfer in General Body-Fitted Coordinates **J. Liu, H. M. Shang, Y. S. Chen, and T. S. Wang**

441 Monotonic, Multidimensional Flux Discretization Scheme for All Peclet Numbers **Tony W. H. Sheu, S. F. Tsai, and S. K. Wang**

459 A BEM Formulation for Evaluating Conductive Heat Transfer Rates in Particulate Systems **N. J. Mariani, S. P. Bressa, G. D. Mazza, O. M. Martínez, and G. F. Barreto**

477 Application of Optimization Methods for Solving Inverse Phase-Change Problems **Nehad Al-Khalidy**

Following page 498:

Title Page to Volume 31
Contents of Volume 31
Author Index to Volume 31
Subject Index to Volume 31